D. BIOLOGICAL DATA

1. Microbiology

Part of the natural bacterial population of the lake consists of coliform organisms which are derived from surface runoff. Fecal coliform bacteria, however, are derived from human and animal wastes. The presence of these bacteria is an indication of potential sewage pollution. It is important to note that fecal coliform bacteria themselves are not pathogenic but are indicators of the possible presence of certain pathogenic organisms such as typhoid or dysentery bacteria.

In order to quantify the extent of the bacterial contamination of the lake, PAS conducted in-lake bacteriological sampling as well as a review of historical bacteriological data.

Six stations within the lake were sampled a total of ten times between April and December 1974 (Levins and Moskowitz, 1977). The results of this sampling program indicate low fecal coliform counts in the spring with an increase as the summer approaches. One possible explanation for this increase is the influx of seasonal residents to the area with the resultant increase in recreational activity and septic system usage and failures. A significant increase in fecal coliform bacteria numbers occurred on 9/3/74. Since this corresponds to the Labor Day holiday weekend the inference can be made that the heavy holiday use of the lake and surrounding area is responsible for bacterial contamination. However, this particular sampling occurred on a rainy day. Fecal coliform bacteria in the watershed, whether of human or animal origin, would be carried into the lake via surface runoff. This would greatly increase the number of these bacteria.

A statistically significant increase in coliform bacteria was also observed during the holiday weekends of Memorial Day, July 4th, and Labor Day, of 1974 and 1975 (Levins and Moskowitz, 1977).

In an effort to study and update the extent of this potential this problem sampling and bacteriological analyses were conducted in 1982. All samples were collected, handled, and analyzed as per Standard Methods for the Examination of Water and Wastewater 14th ed. (1976). No correlation between bacteria counts and holiday weekends was indicated by those data.

A survey of the entire lake shoreline was conducted during the summer of 1982 with an Endeco Type 2100 Septic Leachate Detector System ("Septic Snooper"). Bacteriological sampling and analyses were an integral part of this survey. Those results are treated in a separate section of this report (Section VIII).

2. Phytoplankton

Chlorophyll is a photosynthetic pigment found in phytoplankton, algae and aquatic macrophytes. Its concentration in the water column is often used as an indirect measurement of the density of phytoplankton. As chlorophyll is rapidly degraded upon the death of phytoplankton cells, it is reflective of the density of live photosynthetically active cells. In lake restoration studies the concentration of chlorophyll is often used as a means of expressing in-lake productivity associated with phytoplankton. The concentration of chlorophyll a, b, and c were monitored and contrasted to the concentrations of various nutrients as a means of assessing the seasonality of water column productivity in Lake Hopatcong.

Monthly chlorophyll a values for three sampling sites are compared in Figure 13. This figure points to several factors affecting the growth of algae. The most obvious peaks in chlorophyll values are observed in the spring and fall when optimal sunlight is available for growth. In addition, it is at these times that available nutrients increase due to the seasonal overturn which promotes the mixing of nutrient rich water and stimulation of algal growth. In winter the concentration of chlorophyll a decreases due to the lower algal productivity caused by a decrease in available sunlight and colder temperatures. Fluctuations in the chlorophyll concentrations are due to a variety of factors, including seasonal conditions, the rate of horizontal and vertical mixing of the water, temperature, day length and rapid changes in the composition of plankton populations.

Algal populations with the greatest growth rates occur at LH 1, which is a shallow, enclosed area where the optimal conditions are more likely to exist (Figure 13). At LH 2 algal growth is more constant but occurs at a much slower rate. Chlorophyll a production at site LH 5 is on the average lower than at site LH 1 even though it too is a shallow,

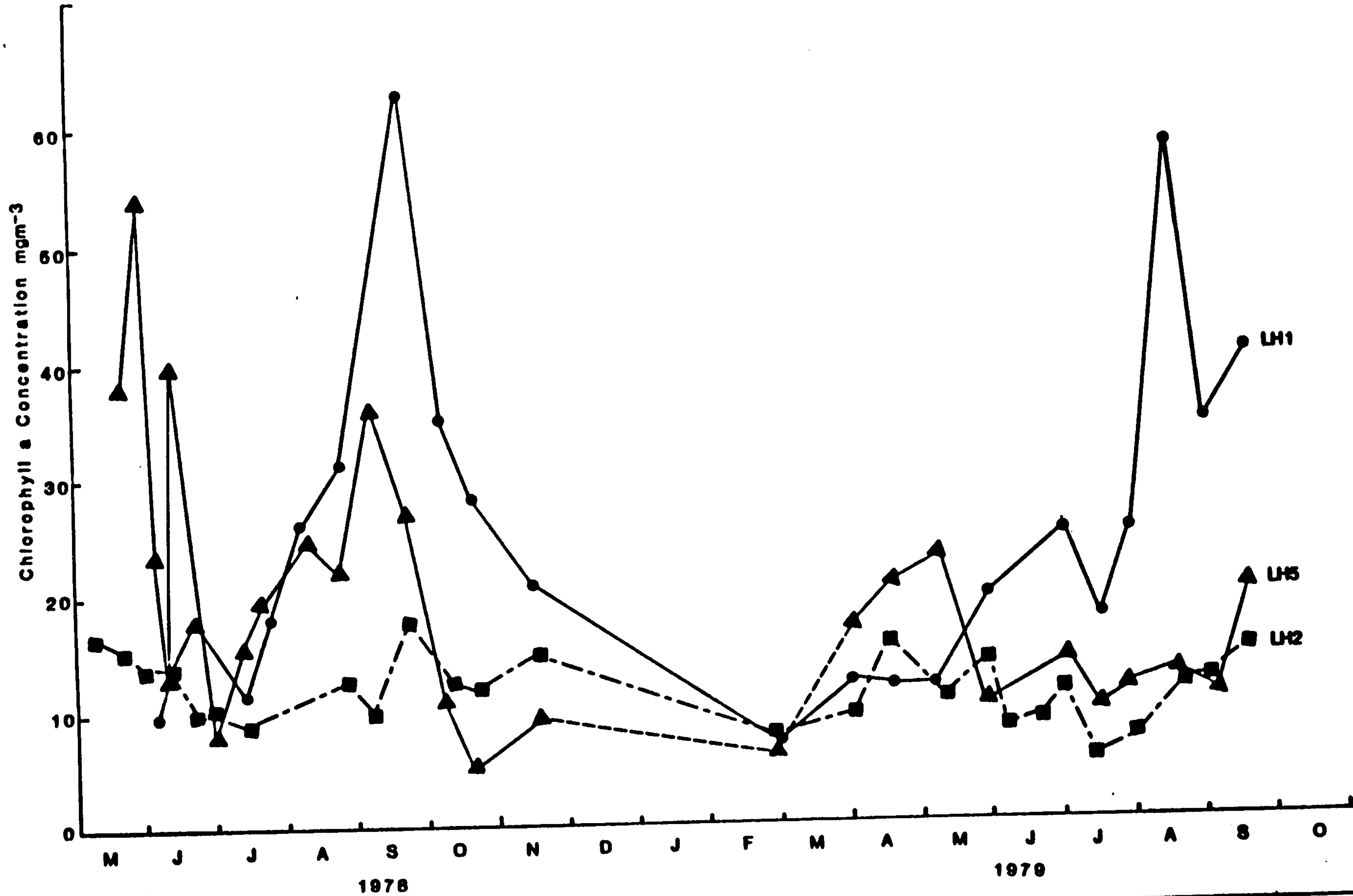


FIGURE 13
TEMPORAL CHANGES IN THE CONCENTRATION OF
CHLOROPHYLL A AT STATIONS LH1, LH2 AND LH5

pas

enclosed area. A possible explanation for this is competition for nutrients by macrophytes which also limit available sunlight through shading.

Secchi disc transparency readings provide another indication of algae standing crops. As algae populations increase, Secchi disc transparency decreases (Figure 14). At LH 1 and LH 5, which have the highest chlorophyll a concentrations, the lowest Secchi disc transparency readings are recorded. At these sites the density of the algae populations result in turbid conditions which increase the attenuation of light.

As discussed earlier algae growth is dependant on the availability of nutrients as well as sunlight. Figure 15 illustrates the correlation between nutrient availability and chlorophyll a concentrations. Peak concentrations of nitrate are measured during the spring following ice-out and lake turnover. Orthophosphate and total phosphate reach peak concentrations during the fall turnover of the lake. Although high nutrient concentrations exist during the winter months ice cover inhibits the penetration of sunlight and thus limits the growth of algae.

Whereas chlorophyll a is found in all types of algae, the proportion of chlorophyll b and c vary in the different planktonic groups. Chlorophyll b and c can differentiate green and euglenoid algae from diatoms and dinoflagellates, respectively. In Woodport Bay, the presence of green and euglenoid algae, exhibited as chlorophyll b, appears to be relatively constant, whereas the density of diatoms and dinoflagellates fluctuate seasonally (Figure 16).

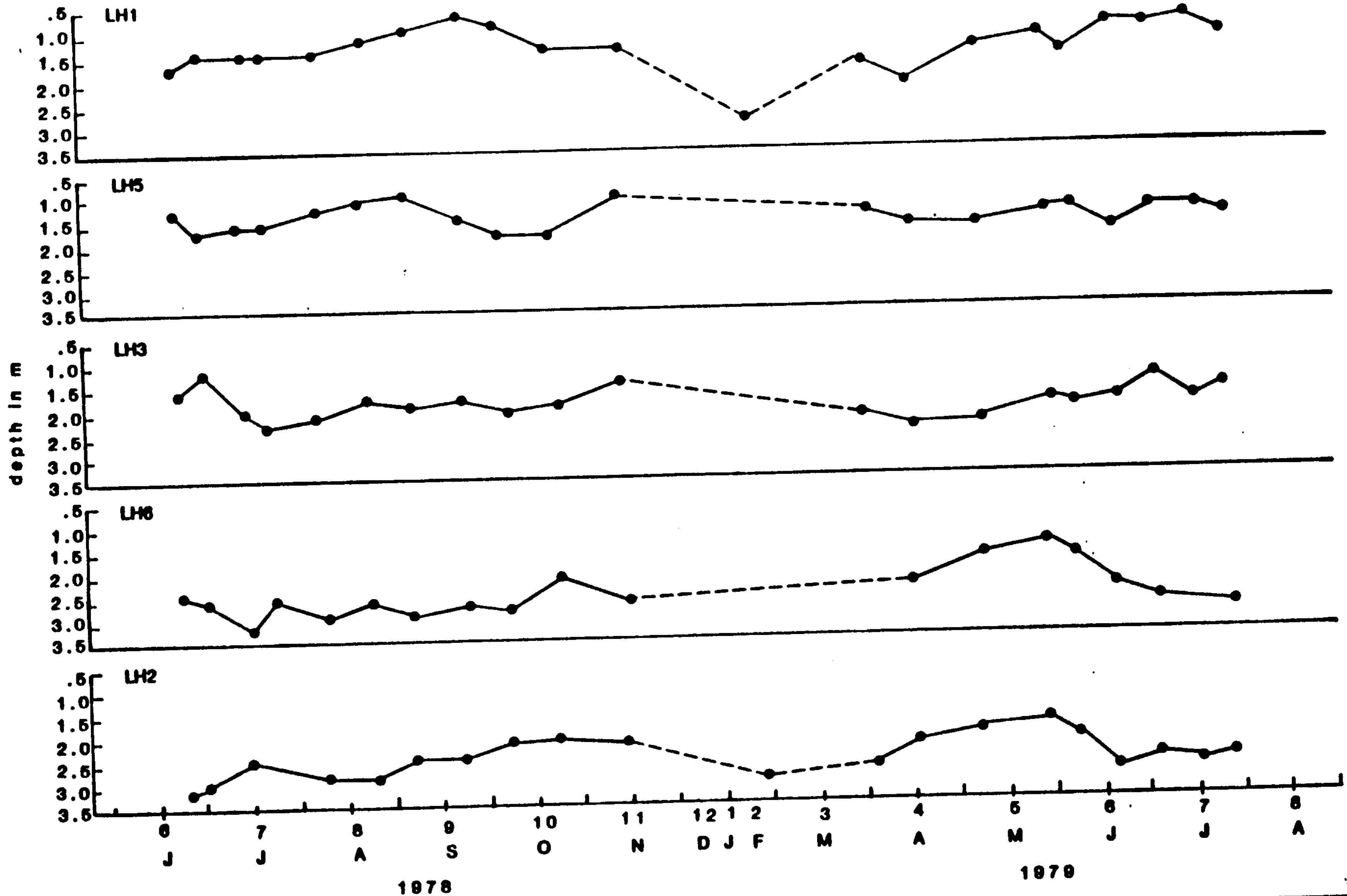


FIGURE 14
SECCHI DISC TRANSPARENCIES FOR 5 SITES
ON LAKE HOPATCONG

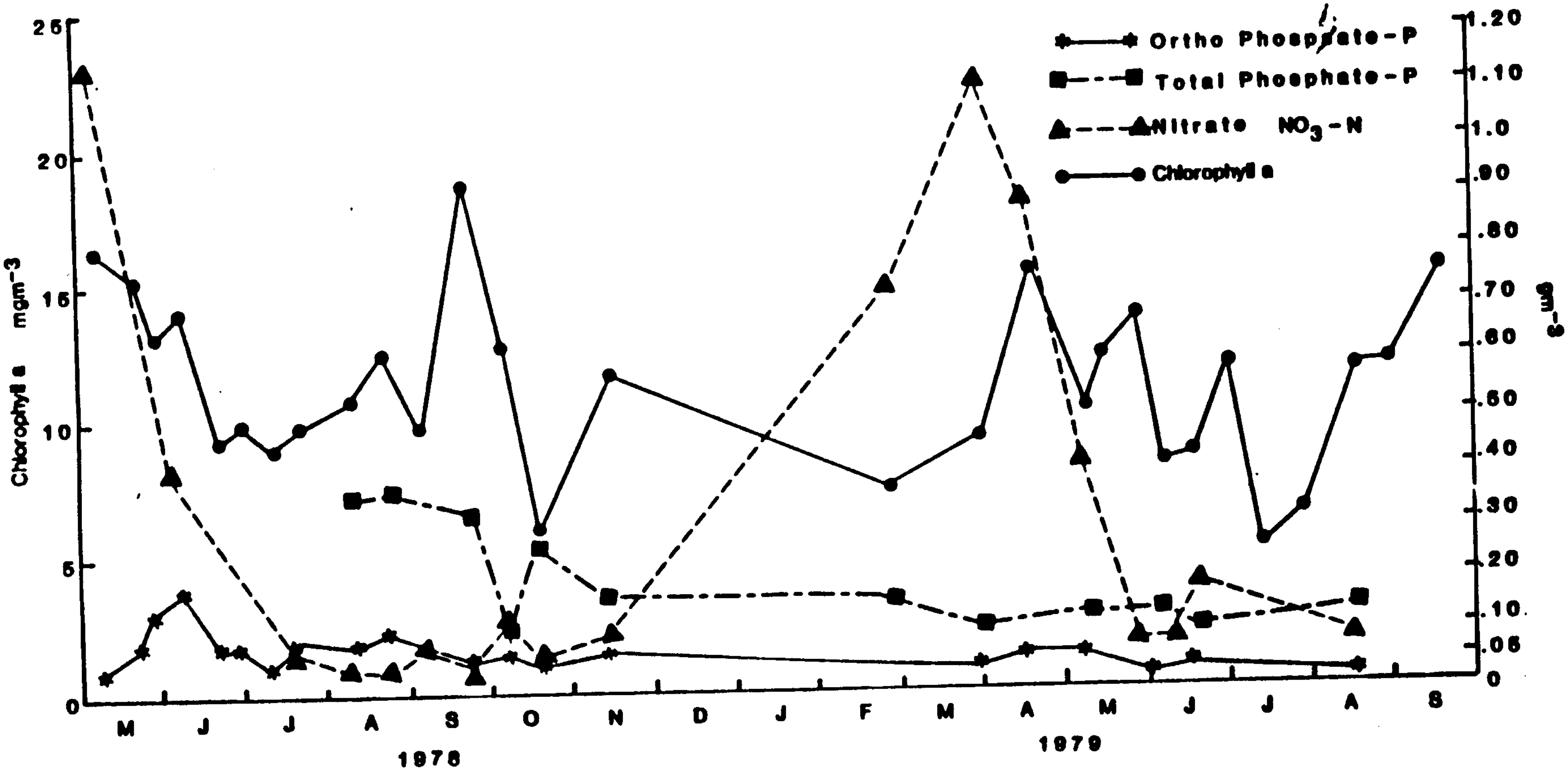


FIGURE 15
CHANGES IN THE CONCENTRATIONS OF CHLOROPHYLL A
AS RELATED TO CHANGES IN THE CONCENTRATION
OF ORTHOPHOSPHATE-P, TOTAL PHOSPHATE - P AND NITRATE - N
AT STATION LH2 , 0.5 METER DEPTH

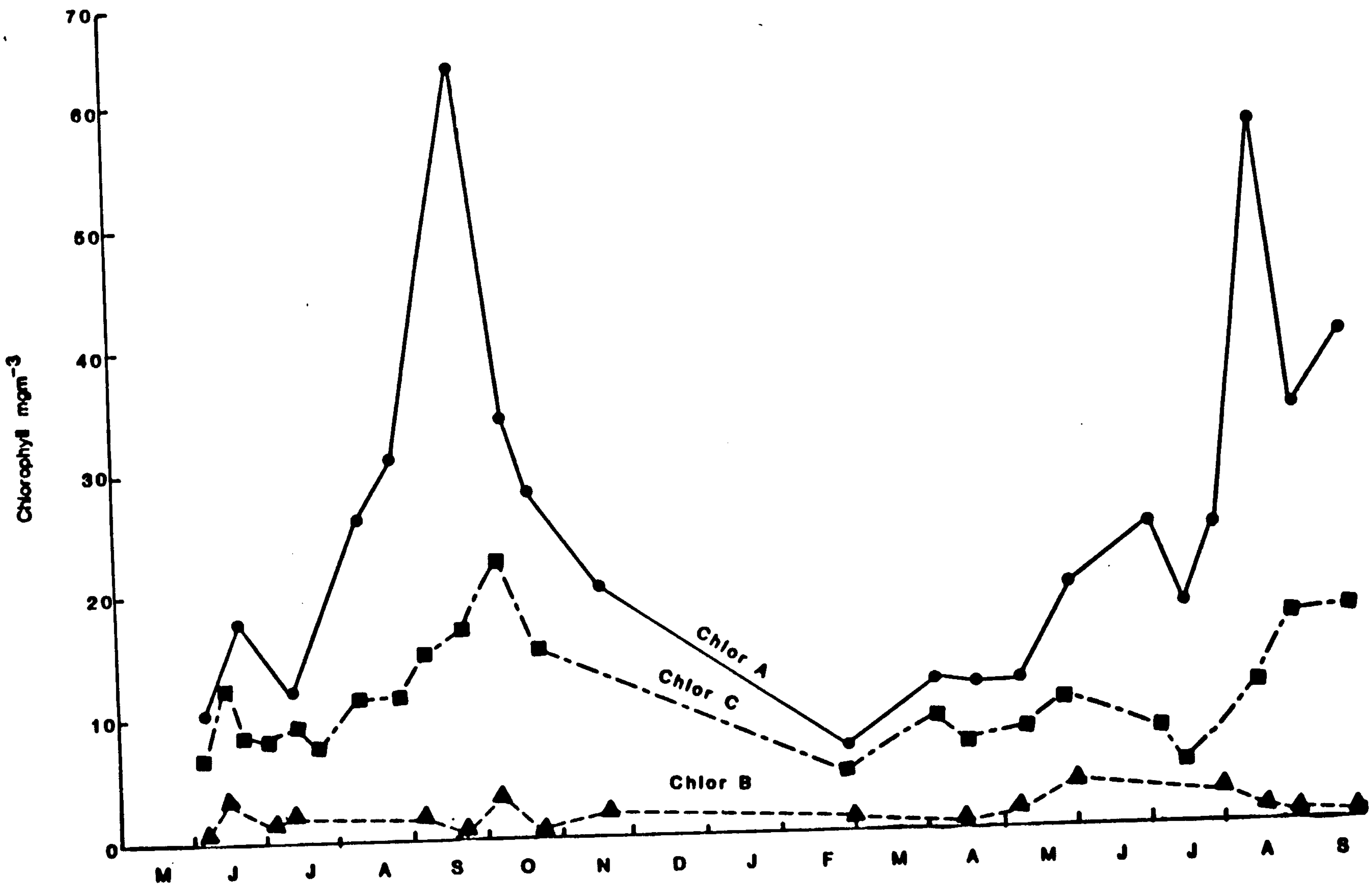


FIGURE 16
TEMPORAL CHANGES IN CHLOROPHYLL A, B AND C
IN WOODPORT BAY , LH1

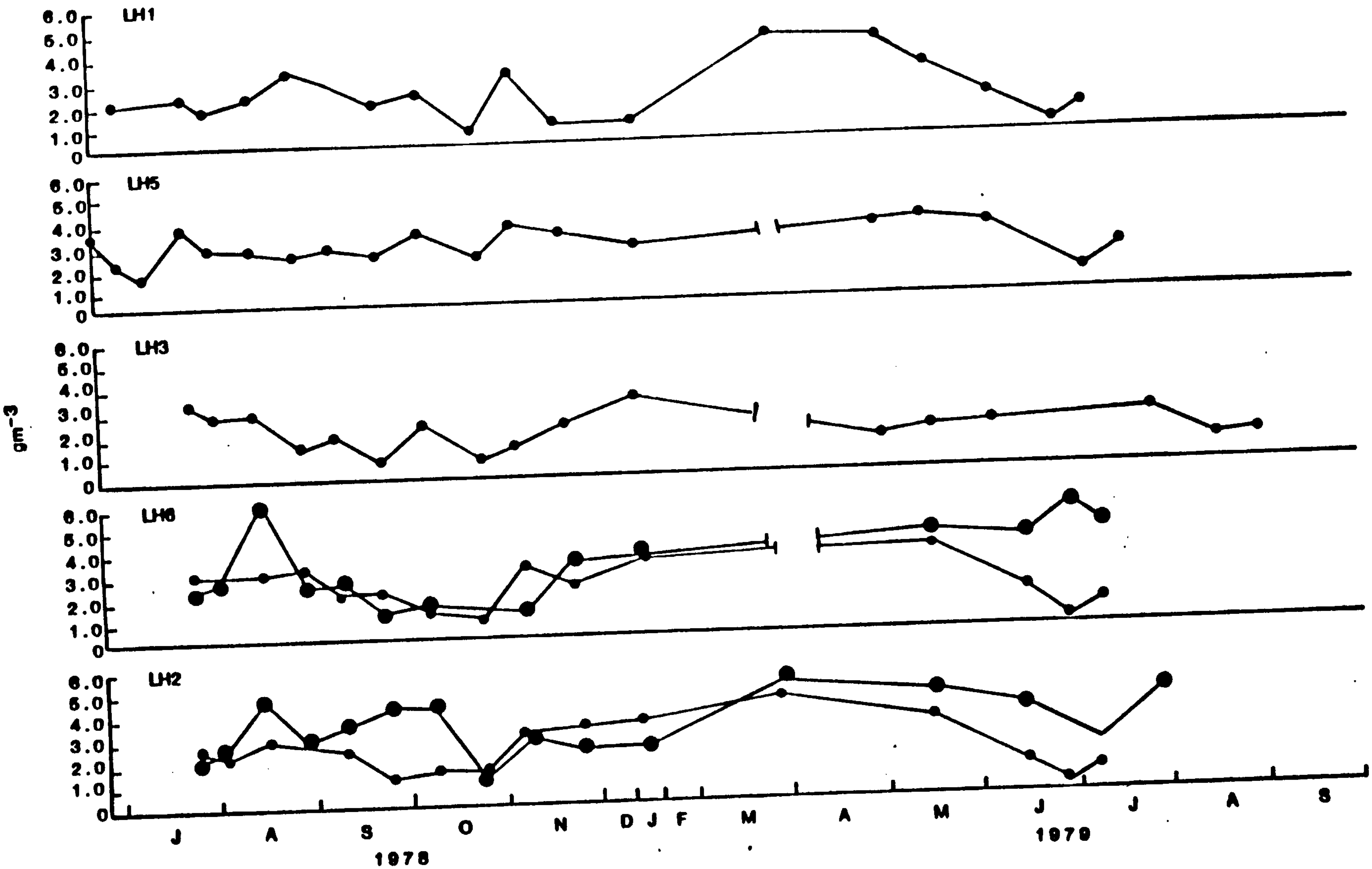
Another parameter by which further delineation between diatoms and dinoflagellates of the chlorophyll c group can be made is free silica. Diatoms use silica to produce cell walls or shells called frustules. The concentrations of free silica are lowest at sites of greatest diatom growth, LH 1, LH 3, and LH 5 (Figure 17). At the deep water sites, LH 2 and LH 6, silica levels are lower near the surface than near the bottom where the lack of sunlight prohibits the growth of diatoms and other phytoplankters. In addition, at lake depths below the euphotic zone, dead cells become decomposed and the silica, once a component of the frustules, is remineralized.

An example of the interrelation between silica and chlorophyll c is presented in Figure 18 developed from data collected at site LH 1. As the chlorophyll c concentration increases (diatom density increase), the concentration of silica decreases and vice versa.

a. Distribution and Abundance by Division

Proportionally the phytoplankton samples from all three stations were dominated by diatoms (LH 3 = 51%; LH 2 = 63%; LH 1 = 45%). At LH 1 and LH 3 blue green algae were second in terms of dominance (LH 1 = 35%; LH 3 = 25%), but were third at LH 2 (13%). The green algae were second in dominance at LH 2 (dominated 21% of samples) and third at LH 1 and LH 3 (dominated 15% and 19%, respectively). Chrysophytes dominated the samples 5% of the time at LH 1 and LH 3 and 3% at LH 2.

With few exceptions, the seasonal distribution is predictable with diatoms dominating generally in spring and blue-greens generally dominating in the warmer months of August and into September. The much greater overall unit densities at LH 1 in the summer are attributed generally to large increases in numbers of blue-green algal units.



• – 0.5 METERS

● – 14.0 METERS

FIGURE 17
SILICA CONCENTRATIONS ($g \cdot m^{-3}$) FOR 5 SITES
ON LAKE HOPATCONG DURING 1978 AND 1979

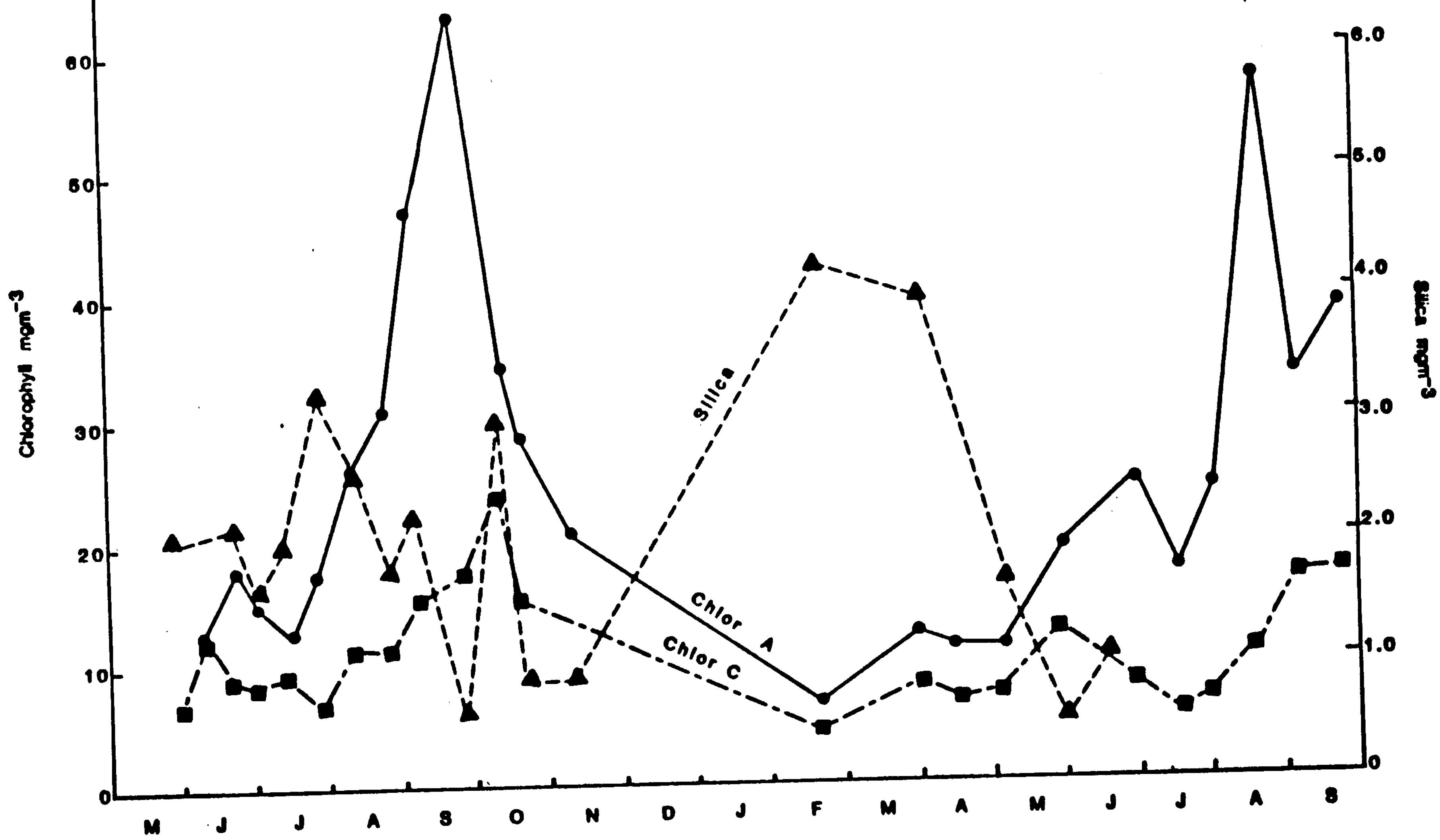


FIGURE 18
TEMPORAL CHANGES IN CHLOROPHYLL A , CHLOROPHYLL C
AND SILICA IN WOODPORT BAY, LH1.

The biomass of the algal genera expressed as volume (m^3) is summarized in Table 35. The centric diatom genus Melosira had the greatest volume biomass at all three stations. At LH 1 this was followed by Gleocystis, Pediastrum, Coccoid greens, and Scenedesmus. At LH 3 Melosira was followed by Coccoid greens, Dinobryon, Gleocystis, and Pediastrum; at LH 2 it was followed by Synedra, Coccoid green, Tabellaria and other centric diatoms.

Table 35

LAKE HOPATCONG PHYTOPLANKTON VOLUME DATA

	LH 1							LH 3							LH 2						
	RANK	FREQ%	Occurrence as Dominance					RANK	FREQ%	Occurrence as Dominance					RANK	FREQ%	Occurrence as Dominance				
			1	2	3	4	5			1	2	3	4	5			1	2	3	4	5
Melosira	1	97	25	1	2	2	0	1	87	22	3	1	2	2	1	58	8	5	4	1	1
Coccoid Green	4	100	1	4	5	9	7	2	100	3	16	8	3	0	3	100	8	11	6	4	2
Dinobryon	6	67	4	2	2	2	1	3	81	3	7	2	4	2	16	84	5	4	2	2	2
Gleocystes	2	68	2	3	1	6	8	4	76	5	2	5	3	3	6	82	2	0	3	5	6
Pediastrum	3	91	0	14	4	5	2	5	59	0	3	6	8	4	9	24	2	2	2	2	1
Synedra	11	88	2	1	2	0	1	6	89	3	1	2	1	3	2	92	4	2	1	0	2
Tabellaria	7	94	0	2	2	4	1	7	89	1	0	5	6	4	4	89	5	5	5	1	2
Scenedesmus	5	91	0	2	5	1	10	8	87	0	2	2	6	8	7	66	0	1	4	3	4
Oocystes	15	67	0	0	0	0	0	9	57	0	0	2	0	1	11	53	0	0	0	5	1
Centric Diatom	10	97	0	1	0	1	1	10	100	0	1	1	4	2	5	100	0	3	5	8	4
Chroococcus	14	36	0	1	2	0	0	11	49	0	0	2	2	1	12	50	0	1	2	1	2
Peridinium	16	15	0	1	0	0	0	12	14	0	1	1	0	1	13	18	1	0	2	1	2
Anabaena	8	79	0	0	4	2	2	13	51	0	0	1	0	3	16	58	0	0	0	1	0
Trachelomonas	12	55	0	0	0	0	1	14	62	0	0	0	1	3	10	37	1	0	2	2	1
Collosphaerium	9	39	0	1	2	0	0	15	22	0	0	0	0	0							
Microcystes								16	65	0	0	0	0	0							
Asterionella	13	91	0	0	0	2	1								14	74	0	0	0	1	5
Glenodinium															8	37	1	2	0	2	3
Total # Samples	33							37							38						
Avg. Val. Dom.	1.0×10^{10}							1.0×10^{9}							1.6×10^{9}						

3. Aquatic Vegetation

An important part of any lake eutrophication study is a survey of the aquatic macrophyte (weed) communities of that lake. In excessive densities, emergent and semi-emergent plants can drastically hinder the recreational uses of a water body. These weeds impede the movement of boats and swimmers and make fishing difficult.

An abundance of aquatic macrophytes also causes drastic diurnal fluctuations in dissolved oxygen levels in the water column. During the day, photosynthesis takes place in the euphotic zone of the lake causing an increase in dissolved oxygen. During the night, however, these same plants cease to produce oxygen, and respire causing a drastic decrease in dissolved oxygen. This may prove taxing to fish species which can not tolerate low dissolved oxygen concentrations. Oxygen is also depleted by the bacterial decomposition of dead plant material that has settled to the bottom of the lake.

Associated with the decay of plant material is the liberation of various nutrients essential to plant growth. These nutrients are usually chemically complexed with the sediments but under anoxic conditions are released and recycled into the water column. This may facilitate either algal blooms or further growth of macrophytes. In addition, the rooted macrophytes utilize the sediment bound nutrients. Such plants rely on their roots and rhizomes to "tap" into this nutrient pool (Prentki, 1979).

Another detrimental consequence associated with the death of aquatic macrophytes is the filling in of the lake. Deposition of allochthonous organic material may represent a significant component of accumulated sediment, particularly in shallow bays which flush infrequently.

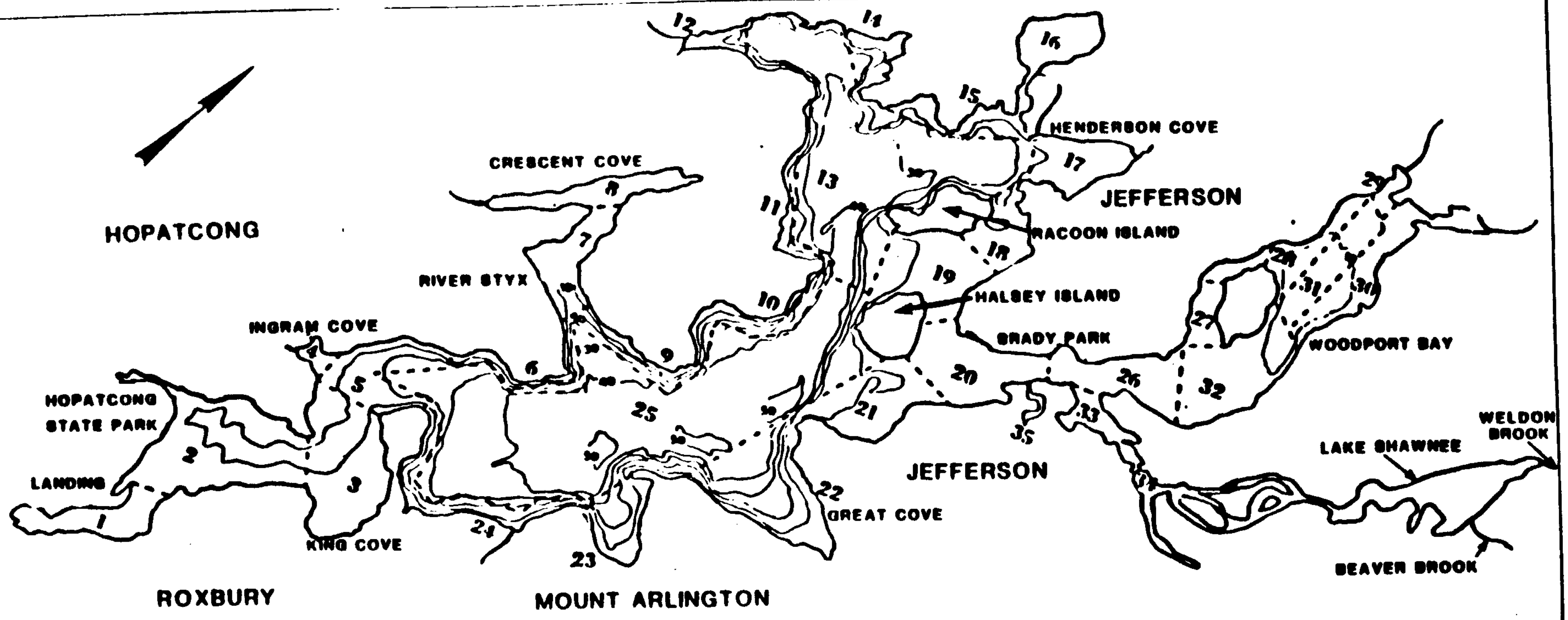
The goal of any management plan should not be to totally eliminate all aquatic macrophyte. A certain amount of weed growth is desirable. As well as being aesthetically pleasing, these weeds serve as forage and shelter for many fish and invertebrate species. Also, complete elimination of these plants may lead to the development of nuisance algal blooms.

The aquatic macrophytes were sampled, identified and mapped in an intensive survey of Lake Hopatcong conducted during the growing season (May-September) of 1978 and 1979. A combination of methods were used including surface reconnaissance, grapple, and SCUBA. The selection of a particular method was dependant primarily on the depth and clarity of the water. In addition, continual observations of the vegetation were made on each date of in-lake sampling from August 1981 through August 1982.

During the study, 250 transects were examined by the techniques described above to determine the species composition, relative abundance, and dominant species.

The emphasis of the macrophyte survey was placed on defining the different vegetative associations within the various bays and coves of the lake. Therefore, the lake was divided into 35 zones for the purpose of simplifying data analysis (Figure 19). A summary of the 1978 findings is presented in Table 36. Table 37 summarizes the problem species identified in the aquatic macrophyte survey.

The southern end of the lake encompassing the Landing Channel, State Park area, Pt. Pleasant, and King's Cove to Ingram's Cove was dominated by *Myriophyllum spicatum*, *Najas guadalupensis*, and *Valisneria americana*. These plants often reach the water's surface. A fairly homogenous plant community in this entire area is not surprising as the substrate is,



LEGEND

10 MACROPHYTE ZONE

FEET
0 1000 2000

0 200 400
METERS

DEPTHS IN FEET

LAKE HOPATCONG REGIONAL PLANNING BOARD

LAKE RESTORATION AND MANAGEMENT STUDY

FIGURE 19

LAKE HOPATCONG MACROPHYTE ZONES

pas

Table 36

DISTRIBUTION AND ESTIMATED ABUNDANCE OF
AQUATIC MACROPHYTES IN LAKE HOPATCONG

Species	Zone* 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Number of Zones	%
Myriophyllum spicatum	S	P	C	S	P	N	S	S	N	N	N	N	S	-	N	-	S	S	S	S	S	N	S	N	N	S	P	P	C	P	N	P	C	A	P	23	70%
Valioneria americana	P	P	P	D	P	S	S	C	P	S	S	P	N	-	S	-	P	C	P	P	S	P	P	P	S	C	C	P	C	P	S	C	C	C	C	31	94%
Najas guadalupensis	P	A	A	P	A	C	C	P	A	A	A	A	S	-	A	-	C	C	C	A	A	C	C	P	S	A	P	C	P	C	S	A	A	C	C	33	100%
Najas flexilis	S	S	N	N	N	S	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	S	N	N	S	N	N	N	N	N	N	S	S	8	24%
Nitella flexilia	P	S	S	N	S	O	S	S	N	P	P	P	S	-	P	-	S	S	P	C	P	C	P	P	S	C	P	S	P	C	S	P	C	C	S	31	94%
Potamogeton amplifolius	N	S	S	P	P	S	P	S	S	P	P	N	N	-	S	-	P	S	P	N	S	S	P	S	N	S	S	P	S	C	S	S	P	A	P	28	85%
Potamogeton diversifolius	S	S	N	N	N	N	S	N	N	S	S	N	N	-	N	-	N	N	S	N	N	N	S	N	N	S	S	N	N	N	N	N	N	S	S	10	30%
Potamogeton gramineus	N	S	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	S	N	N	N	N	N	N	N	N	N	N	N	N	N	S	S	4	12%
Potamogeton orispus	S	S	S	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	S	S	N	N	N	N	N	N	N	N	N	N	N	S	N	6	18%
Potamogeton perfoliatus	N	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P	2	6%
Potamogeton epihydrus	N	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	N	N	N	S	N	N	N	N	N	N	S	N	2	6%
Sagittaria graminea	S	N	N	N	N	N	S	N	N	N	N	N	S	-	N	-	N	S	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	C	C	7	21%
Nuphar advena	S	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	N	N	N	C	N	N	N	N	N	N	A	P	4	12%
Nymphea odorata	N	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	C	N	1	3%
Branenia schreberii	N	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	N	N	N	P	N	N	N	N	N	N	C	S	3	9%
Potamogeton robbinsii	N	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	S	N	N	N	N	N	N	N	N	S	S	N	3	9%
Utricularia vulgaris	N	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	N	N	N	P	N	N	N	N	N	N	P	S	3	9%
Myriophyllum sp.	N	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	N	N	N	P	N	N	N	N	N	N	S	N	2	6%
Nymphea sp.	N	N	N	N	N	N	N	N	N	N	N	N	N	-	N	-	N	N	N	N	N	N	N	N	N	N	P	N	N	N	N	N	N	N	N	1	3%
Lyngbya lattisma[1]	S	N	N	N	N	N	A	A	N	N	N	S	S	-	P	-	A	P	S	N	N	N	S	N	PS	N	N	C	N	S	P	N	N	N	N	14	42%
TOTAL SPECIES ENCOUNTERED	10	9	6	4	5	5	8	6	3	6	5	4	5	-	5	-	6	7	7	5	6	6	7	6	3	6	13	6	5	6	5	5	6	18	13	-	-

[1]This is a blue-green algae that forms dense benthic mats.

*Shown in Figure 19.

N = None
S = Sparse
P = Present
C = Common

A = Abundant (codominant)
D = Dominant
PS = Pure Stand

Table 37

IDENTIFIED PROBLEM AQUATIC MACROPHYTE SPECIES IN LAKE HOPATCONG

Myriophyllum spicatum	milfoil
Potamogeton sp.	pond weed
Nuphar advena	yellow water lily
Valisenaria americana	water celery
Najas sp.	bushy pond weed
Lyngbya lattisima*	

*blue-green algae which forms dense mats on bottom of lake.

with little variation, mostly mucky throughout this portion of the lake. Depths here are mostly less than 3 meters allowing light penetration to the bottom and facilitating the development of dense to moderate weed growth. Some of the other observed macrophytes are Potamogeton crispus and Najas flexilis as well as Nitella flexilis a filamentous green algae.

Ingram Cove is a shallow cove (less than 2 m) with a bottom consisting mostly of muck. Once again Myriophyllum spicatum and Valisneria americana are found in dense concentrations. Potamogeton ampifolius is also a predominate species. Najas guadalupensis and Nitella flexilis are also present.

Myriophyllum spicatum, Valisneria americana, Najas guadalupensis and Lyngbya lattisma, a blue-green algae, are the dominant species in the River Styx/Crescent Cove area. Their dense growth, especially in Crescent Cove, is a result of the mucky substrate and shallow nature (less than 2 m) of that area.

Byram Cove showed a diversity of species composition. The mucky bottom in the Turtle Point area supports Najas guadalupensis and Elodea nutalii as the dominant species. As the depth increases to a maximum of 13 m toward Byram Bay, the substrate becomes more rocky and Nitella flexilis, with no rooting requirements, becomes dominant. Byram Cove near Knollwood contains a mixed rock, sand, and muck bottom with an accompanying mixture of predominant plant species. Besides Najas guadalupensis and Nitella flexilis; Myriophyllum spicatum, Potamogeton ampifolius, and Valisneria americana were observed to be dominant in this area of the lake.

Henderson Cove is another shallow, soft-bottomed area with moderately dense weed growth dominated by Myriophyllum spicatum, Najas guadalupensis, Potamogeton ampifolius as well as the algae Lyngbya lattisma.

Both Van Every Cove and Great Cove on the western side of the lake are deeper areas (up to 16 m deep) and therefore support only moderately dense to very sparse growth of aquatic macrophytes. Najas guadalupensis and the algae Nitella flexilis were found to be dominant in both coves with Myriophyllum spicatum and Valisneria americana codominant in Great Cove.

The deepest portion of the lake is the open, mid-lake area with depths up to 17 m. Since light penetration to the bottom occurs only in the shallow areas of the lake, plant growth was found to be very sparse with only the algae Nitella flexilis occurring as the dominant species in the upper euphotic zone of this section of the lake. Najas guadalupensis and Lyngbya lattisma were the only other species observed in the mid-lake area.

A very productive area in terms of macrophytic growth is Stump Cove. The entire cove is shallow (maximum depth approximately 1.5 m) and supports a dense and diverse plant community structure. Among the dominant plant species encountered are Myriophyllum spicatum, Valisneria americana, Najas guadalupensis, Nuphar advena, and Brasenia schreberii. Here too, the mucky bottom is conducive to plant growth.

Rather sparse vegetation was found in the center of Woodport Bay. The depth (up to 6 m) would account for this. Lyngbya lattissima and algae with no rooting requirements, appeared to be the dominant species with Valisneria americana, Najas guadalupensis, Nitella flexilis, and Potamogeton ampifolius also collected.

Woodport Cove at the extreme north end of the lake has a mucky bottom and is very shallow (less than 2 m). Dense growths of Myriophyllum spicatum and Valisneria americana were encountered along with Najas guadalupensis, Potamogeton ampifolius, and Nuphar advena.

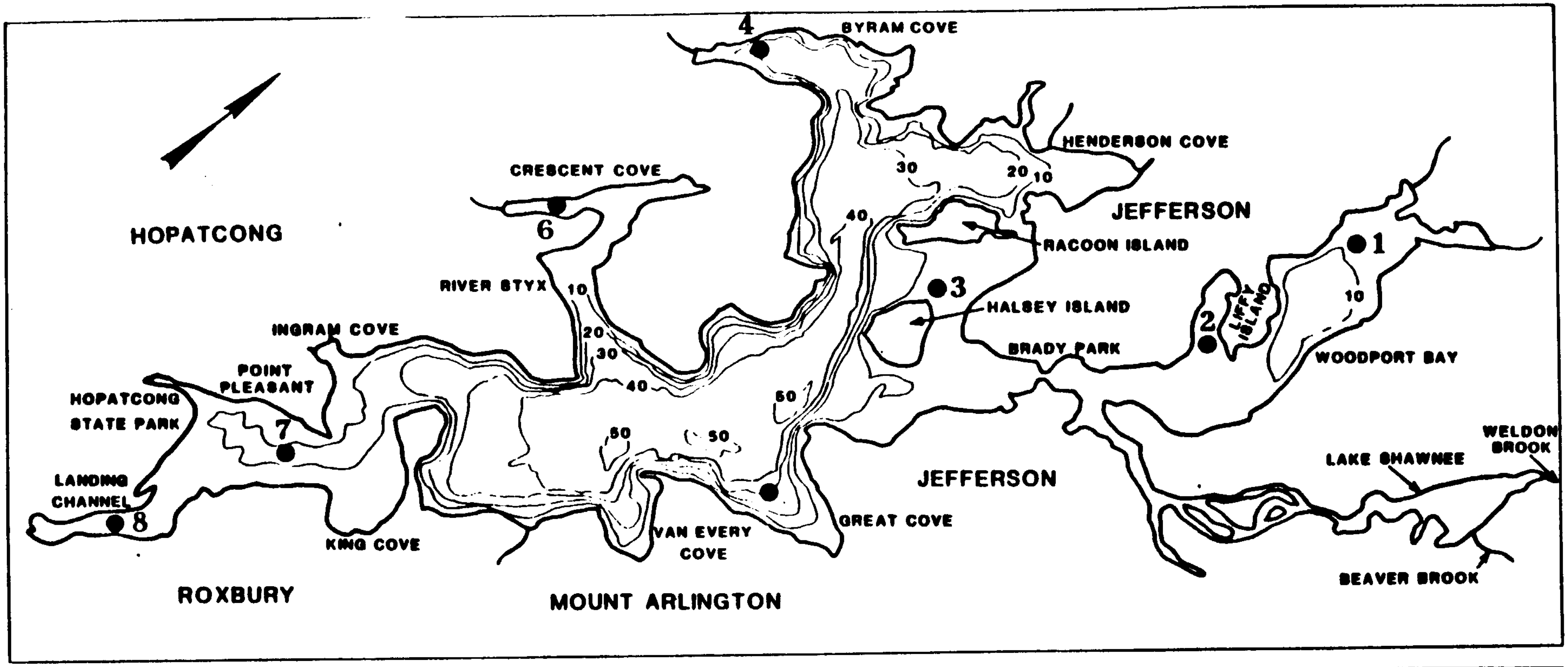
4. Benthos

On April 13, 1983 bottom grab samples were taken with an Ekman Dredge at eight locations throughout the lake (Figure 20). All samples were taken at sites where water depth ranged between 1 and 2 meters. Samples were sorted using 1000 µm and 500 µm screens. Organisms were identified to lowest possible taxon. Species diversity and percent composition were computed (Table 38). These data were used along with field observations to assess the benthic community structure and sediment-fauna ecological relationships.

Station #1, in Woodport Bay, was characterized by a high species diversity and eveness. In this shallow section of the lake the sediments are highly organic. Oxygen levels at the mud-water interface, while possibly becoming depressed at times, do not become depleted. Chrionomids and tubificids, low D.O. tolerant species, were found along with Gastropods which cannot tolerate very low D.O.'s for extended periods (Pennak, 1978).

Station #2 in the Liffy Island, Stump Cove area, is shallow, and characterized by dense stands of aquatic macrophytes. The sediments at this site are also highly organic being composed of partially decomposed plant tissue. The thick peat-like sediment had an anaerobic odor. Tubificids were found in the muck, while Gastropods were found associated with the Nuphar shoots. Species diversity and eveness were low; however, this could be a result of sampling difficulty due to the abundance of aquatic macrophytes.

The Station 3, Halsey Island, sample was dominated by Chironomids; hence, low species diversity and eveness. The sediments of this site are comprised mostly of moderately coarse sand and little organic matter. The density of macrophytes is sparse. The combination of



LEGEND:

2 ● BENTHOS SAMPLING SITES

FEET
0 1000 2000
0 200 400
METERS

DEPTHS IN FEET

LAKE HOPATCONG REGIONAL PLANNING BOARD

LAKE RESTORATION AND MANAGEMENT STUDY

FIGURE 20

LAKE HOPATCONG BENTHIC INVERTEBRATES SAMPLING STATIONS

Table 38

DISTRIBUTION AND PERCENT COMPOSITION OF
BENTHIC INVERTEBRATES SAMPLED IN
LAKE HOPATCONG

		Station															
		1		2		3		4		5		6		7		8	
Organism*		# org.	% comp.	# org.	% comp.	# org.	% comp.	# org.	% comp.	# org.	% comp.	# org.	% comp.	# org.	% comp.	# org.	% comp.
CRUSTACEA																	
Gammaridae	Sideswimmers, Scuds																
Gammarus sp.								1	1.54	2	7.41	75	92.6			1	0.467
Asellidae	Aquatic sow-bugs																
Asellus sp.								6	9.23			1	1.23			5	2.34
INSECTA																	
Chrionomidae	Midges	3	30.0			88	98.9	41	63.1	1	3.70					180	84.1
MOLLUSCA																	
Gastropoda	Snails	3	30.0	5	71.4	1	1.10	6	9.23	21	77.8			3	100	17	7.94
Pelecypoda	Clams							4	6.15							6	2.80
OLIGOCHAETA																	
Tubificidae	Aquatic Worms																
Limnodrilus sp.		4	40.0	2	28.6					2	7.41	5	6.17			5	2.34
Naididae	Aquatic Worms																
Najas sp.										1	3.70						
HIRUDINEA	Leeches																
Glossiphoniidae		—		—		—		7	10.8	—		—		—		—	
Total No. Organisms		10		7		89		65		27		81		3		214	
Species Diversity**		1.089		0.5983		0.0617		1.205		0.8255		0.5807		0		0.6463	
Eveness***		0.9909		0.8632		0.0890		0.6724		0.5131		0.5284		0		0.3607	

*Identification according to Pennak, Robert William. Fresh Water Invertebrates of the United States, 2nd ed. John Wiley & Sons, New York, New York, 1978.

**As per Shannon-Weiner Diversity Index where: Diversity $= \ln N - \frac{1}{N}[\Sigma(n_i \ln n_i)]$

where: N = total number of individuals of all species
n_i = number of individuals of the i^{th} species

***Eveness $= \frac{\bar{H}}{\ln S}$

where: $\bar{H}$ = Shannon-Weiner Index
S = number of species

Station #7, off Point Pleasant, had low species diversity or eveness as only snails were collected. This area, at the time of our sampling was covered by dense stands of aquatic macrophytes. The density of the weeds hindered the use of the bottom dredge and may have resulted in a biasing of the sample.

Landing Channel (Station #8) was characterized by fairly high species diversity, low eveness, and a very high total number of organisms. Sediments of this area are mucky, very organic, with a high detrital component. This substrate is also covered by mats of *Najas* sp. The vast majority of the benthic assemblage was comprised of Chironomids. Their ability to tolerate low dissolved oxygen levels has benefited them in this environment where an anaerobic odor was detected upon sediment collection. Also observed here were Gammarids, Asellids, Gastropods, Pelecypods, and Tubificids.

5. Fishery

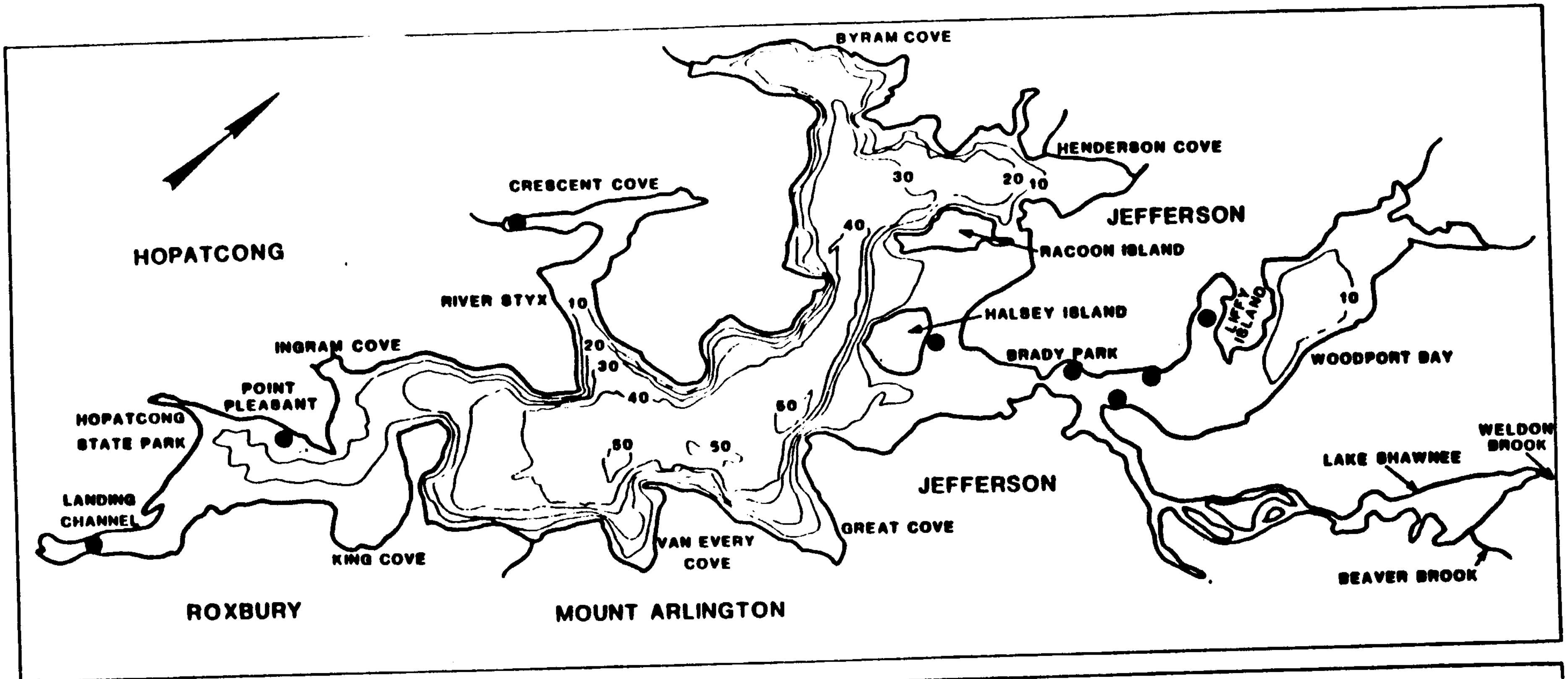
The fish community of Lake Hopatcong was sampled by haul seine at eight sites (Figure 21). The location of the sample sites was determined by accessibility, substrate and weed density. Attempts were made to acquire samples from most of the main sections of the lake.

Samples were collected with a nylon 15 m bag seine, of 1 1/2 cm stretch mesh and 1 1/4 m depth. The seine was "played out" by boat 18 to 20 m from shore. The combined length of the net and the haul lines resulted in an approximately 35 m radius sweep being made for each seine haul.

Upon landing the seine, the length and weight of each specimen was recorded. A triple beam balance was used to measure fish weight. All identifications were made in the field. A small number of specimens were returned to the laboratory. These fish were preserved in a 10% formalin solution. Notes were taken in relation to the sex, presence of gravid females, or the occurrence of males guarding nests.

These data were assessed in conjunction with historical fisheries data, fish stocking records, and data provided by the Lake Hopatcong Knee Deep Hunting and Fishing Club.

Historically, Lake Hopatcong has provided good to excellent fishing for largemouth bass, pickerel, and pan fish (NJDCED, 1950). Pickerel were considered to be the most sought after and landed game fish in the lake. This species provided excellent fishing. Their growth rate was at that time considered very good and many large specimens were routinely caught. Largemouth bass and smallmouth bass provided only fair to good fishing. However, yellow perch were considered an excellent game fish in Lake Hopatcong. These fish were taken in large numbers not only in



LEGEND

● HAUL SEINE SAMPLE

FEET

0 1000 2000

0 200 400

METERS

DEPTHS IN FEET

LAKE HOPATCONG REGIONAL PLANNING BOARD

LAKE RESTORATION AND MANAGEMENT STUDY

FIGURE 21

FISH SAMPLING SITES

pa=

the summer, but in the winter when many of the larger individuals were caught. White perch were found to be abundant and had a growth rate which was considered to be excellent. However, this species was greatly under utilized in the lake. Other pan and game fish which were found in the lake were crappie, pumpkinseed, bluegill, red-breasted sunfish, white catfish, and northern brown bullhead (Table 39).

Of the various pan and game fish sampled, yellow perch were dominant, by number, followed by pickerel, pumpkinseed, and brown bullhead. This data is biased, however, in that it accounts only for the measured specimens. In reality, far more bluegill and pumpkinseed individuals were encountered than measured. In addition, forage fish such as alewife, golden shiner, and minnows were taken in very large numbers.

Although the stocking of the lake with cold water game fish was not highly recommended (NJDCED, 1950) Lake Hopatcong has been and continues to be stocked. During World War I, an experiment was conducted regarding the stocking of landlocked salmon. The program was unsuccessful. Since then, the lake has been stocked with brown trout, rainbow trout, and walleye (Stizostedion vitreum vitreum). The walleye project proved fruitless, but the trout stocking project has had limited success and continues to be a popular venture. At present, 1000 to 1500 fish are stocked annually on a "put and take" basis. The depletion of hypolimnetic oxygen in the deeper parts of the lake during the summer, and the lack of suitable spawning sites does not favor the establishment of a self-supporting trout population.

The results of our study (Tables 40 and 41) indicate that various sections of the lake have diverse community assemblages. The observed differences appear to be a function of weed density, substrate, and water depth.

Table 39

HISTORICAL SPECIES LIST

Salmo trutta	Brown trout (reported)
Salvelinus gairdnerii	Rainbow trout
Micropterus salmoides	Largemouth bass
Micropterus dolomieu	Smallmouth bass
Ambloplites rupestris	Rock bass
Pomoxis nigromaculatus	Crappie, Calico bass
Lepomis macrochirus	Bluegill
Lepomis gibbosus	Pumpkinseed
Lepomis auritus	Red breasted sunfish
Acantharchus pomotis	Mud sunfish
Enneacanthus gloriosus	Bluespotted sunfish
Morone americana	White perch
Esox niger	Chain pickerel
Esox americanus	Grass pickerel
Perca flevescens	Yellow pickerel
Ictalurus nebulosus	Northern brown bullhead
Ictalurus catus	White catfish
Notorus gyrinus	Tadpole madtom
Etheostoma nigrum olmstedi	Johnny darter
Fundulus diaphanus	Freshwater killifish
Alosa psuedoharengus	Alewife
Erimyzon oblongus	Creek chubsucker
Notemigonus crysoleucas	Golden shiner
Notropis sp.	Minnows
Umbra pygmaea	Mudminnow

Table 40

SPECIES LIST FOR FISH OF LAKE HOPATCONG*

Lepomis macrochirus	Bluegill sunfish
Lepomis auritus	Red breasted sunfish
Lepomis gibbosus	Pumpkinseed
Micropterus salmoides	Largemouth bass
Pomoxis nigromaculatus	Black crappie
Perca flavescens	Yellow perch
Esox niger	Chain pickerel
Notropis sp.	Shiner
Notemigonus crysoleucas	Golden shiner
Alasa pseudoharengus	Alewife
Ictalurus nebulosus	Brown bullhead

*Based on PAS haul seine survey.

Table 41

LIST OF SPECIES TAKEN AT LAKE STATIONS

Species	Station * 1	2	3	4	5	6	7	8	9
Lepomis macrochirus	11	SEE TEXT	2	2	2	1	10		27
L. auritus			1	1			2		
L. gibbosus			4	8	10	3	22		1
Micropterus salmoides	3				2				2
Pomoxis nigromaculatus	2		2	1					
Perca flavescens	4		4	12	6				3
Esox niger	1			2			1		2
Notropis sp.			5		4			4	
Notemigonus crysoleucas	7		13	8	31				
Alosa pseudoharengus			71	72	1				
Ictalurus nebulosus				1					
Total No. Organisms	28		102	107	56	4	35	4	35
Species Diversity**	1.54		1.11	1.18	1.38	0.56	0.91	0	0.83
Eveness Index***	0.859		0.534	0.537	0.709	0.808	0.656	-	0.516

*Station Locations:

1. Liffy Island, north side
2. Liffy Island, south side
3. Woodport Bay, south of Liffy Island
4. Woodport Bay, Callaghan's Island
5. Woodport Bay, north of Brady Bridge
6. Halsey Island, northeast side
7. River Styx, Crescent Cove
8. Point Pleasant
9. Landing Channel

**As per Shannon-Weiner Diversity Index where Diversity = $\ln N - \frac{1}{N} \Sigma [ni \ln (ni)]$

where N = total number of individuals of all species

ni = number of individuals of the i^{th} species

***Eveness = $\frac{\bar{H}}{\ln S}$ where $\bar{H}$ = Shannon-Weiner Index

S = number of species

Analysis of the fishery relative to species diversity, evenness, and total number of fish collected reveals that the lake north of Brady Bridge (Woodport Bay) to be the most productive section of the lake. The aquatic macrophytes in this area appear to provide suitable habitat for prey and forage organisms, as well as suitable habitat for nesting and growth of juvenile fish.

Station #1 on the north side of Liffy Island proved to have the highest species diversity and evenness of all stations. The total number of fish caught, however, was not great due to the rocky, stumpy nature of the lake bottom. The nature of the substrate impeded sampling somewhat. Bluegill sunfish (Lepomis macrochirus) and golden shiner (Notemigonus crysoleucas) were well represented in the sampling along with adult largemouth bass, pickerel, and perch.

The south side of Liffy Island (Station #2) is an area of abundant weed growth. The density of weeds hindered sampling. However, on the basis of observation and the limited success of our sampling efforts, this area appears to be an important nursery area. An abundance of young-of-the-year centrarchids, including largemouth bass, were sampled.

Stations #3, #4 and #5 all were characterized by high species diversity and intermediate evenness. These three stations yielded the greatest total number of fish with a total of eleven different species being represented. Golden shiners were the most common fish at Station #5 while the alewife (Alosa pseudoharengus) was the most prevalent species at Stations #3 and #4. Both shiners and alewife provide suitable forage for important game fish such as bass and pickerel. Alewife, due to preferential feeding behavior, can potentially disrupt the species composition of the lake's zooplankton community and indirectly lead to increased algal densities. As a result of their feeding ecology, large zooplankters are preferentially preyed upon. This results in a zooplankton assemblage composed essentially of smaller forms. The smaller oganisms are less effective in reducing the density of the phytoplankton through grazing. In addition, the smaller forms tend to recycle phosphorus, via excretion, much more rapidly than do the larger forms. As a result, phytoplankton numbers are not as effectively controlled and may even be stimulated (Shapiro, 1978). Thus, the occurrence of alewives in Lake Hopatcong is important to both the lake's fishery, and its phytoplankton dynamics. It will need to receive closer attention in relation too the restoration of the lake.

The fishery on the northeast side of Halsey Island (Station #6), while showing a fairly high evenness, was characterized by both a very low total number of fish and low species diversity. In this section of the lake the sediments are very sandy and weed growth is sparse. In close proximity to this sampling site is the deep main body of the lake. Hypolimnetic oxygen depletion occurs in the deep section of the lake throughout summer months resulting in loss of approximately 20% of the lake as viable fish habitat. This is important in that these waters remain cool all summer and were it not for low D.O. would be excellent trout habitat.

The Crescent Cove/River Styx section of the lake (Station #7) is another shallow, weedy area. Species diversity, total number and evenness were fairly high. Centrarchids (sunfish) were the dominant members of the fish community. Fish were observed guarding nests. Also observed, but not captured for positive identirication was what appeared to be a common carp (Cyprinus carpio). In addition, on a separate date the common goldfish (Carrasius auritus) was collected. The occurrence of these species may prove significant in relation to both the fishery and nutrient budget of the lake. Both fish, but especially carp, due to their foraging behavior, often disrupt suitable spawning sites and habitat necessary for many other fish including game species. In addition, these fish have been demonstrated to play an important role in the in-lake recycling of phosphorus (Lamarra, 1975). The amount of nutrients excreted by these fish and liberated during their bottom feeding activities can be substantial (Lamarra, 1975, Shapiro, 1978). It should be noted that no fishery survey of the lake, including our own, has yet to determine if a viable population of carp is actually established in the lake. However, efforts should be made to eliminate these fish from the lake, or maintain their population to a minimum, before any negative effects are observed.

The sampling site of least species diversity and evenness was Station #8 at Point Pleasant. Only one fish species was collected; however, the lack of a suitable landing site for the seine may have biased the sampling effort.

Station #9 in the Landing Channel was characterized by relatively high values for species diversity and total number of organisms and intermediate evenness. This shallow water area has a highly organic substrate and variety of aquatic macrophytes. In addition, a small island composed essentially of stumps is located in the center of the channel. These various components of the habitat seem to provide fairly good cover. However, in this section of the lake, unlike in Stump Cove, sunfish, notably bluegills, greatly predominate the population, causing it to be more unbalanced and less diverse.

In general the fishery of Lake Hopatcong appears to be in fairly good shape. Although our sampling indicates there is an overabundance of sunfish and an underabundance of game species, or method of collection prohibited adequate sampling of most larger fish. Review of records maintained by the Knee Deep Hunting and Fishing Club of Lake Hopatcong show the lake to be an excellent largemouth bass and pickerel fishery and a fair trout fishery. The lake still holds the record catch for channel catfish (1978), white perch (1950), and brook trout (1958).

Preservation of the Liffy Island, Stump Cove area is highly recommended due to the nursery nature of this area. A reduction in weed densities in Crescent Cove and Landing would probably improve the fishing inthese areas. Not only would such action improve access and angling, but would aid in the foraging success of adult bass and pickerel on the numerous sunfish which overpopulate these two embayments.